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BUCKEYE POISONING OF THE HONEY BEE

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Beekeepers have long disagreed as to the value of the California buckeye (*Aesculus californica* Nuttall) as a honey plant. Some have insisted that bees are killed by feeding on its nectar, while others are equally insistent that it is a valuable and safe source of honey. This divergence of opinion among honey producers can be readily understood after studying the known facts of the problem. A knowledge especially of the peculiar distribution of the buckeye and of the climatic conditions governing its growth are necessary to this understanding.

A study of the California buckeye in relation to beekeeping, as extended as funds would permit, was undertaken in October, 1923. Although the work has not been completed, sufficient data are now available to give beekeepers information which will be of value to them.

Enough experimental evidence has been collected to show definitely that wherever buckeye is abundant it is seriously injurious to bees during years when a deficiency in top soil moisture exists, or when, for any reason, other plants fail to produce enough nectar to be more attractive to the hive bee than this plant. *Aesculus californica* is a deep-rooted plant and is not seriously affected by drought.

California buckeye is not found over the entire state. It is confined to a foothill zone extending around the Sacramento and San Joaquin valleys (see fig. 1). This zone reaches the ocean at various places from Mendocino to Ventura counties and extends eastward into the Antelope Valley of Los Angeles County. The habitat of the

buckeye varies greatly in different regions as it depends to a marked extent upon the nature of the soil, direction of prevailing winds, mean temperature, slope, exposure, and other factors. In some places it is to be found on only one side of a cañon or even only in sheltered pockets of one side. There are two districts, however, in which it is

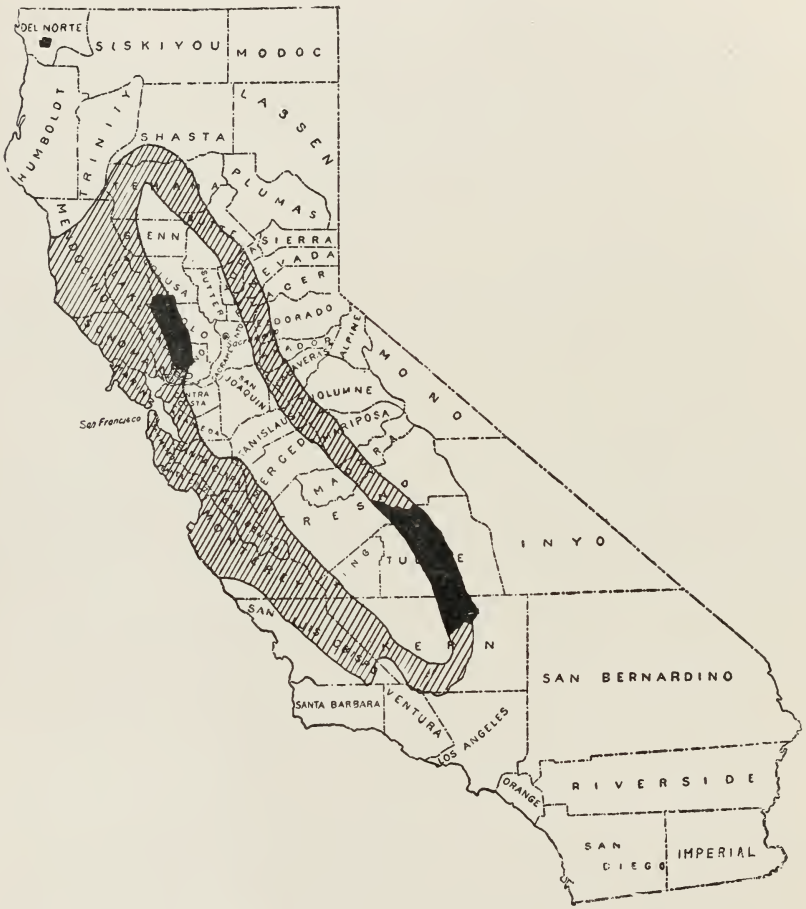


Fig. 1.—The distribution area of the California buckeye is roughly shown by the lining, while the two black spots indicate abundance.

exceedingly abundant on practically all exposures. One of these extends from above Three Rivers in Tulare County into Kern County, the other from northern Yolo County southward through Solano and Napa counties (see fig. 1). As is the case with the majority of

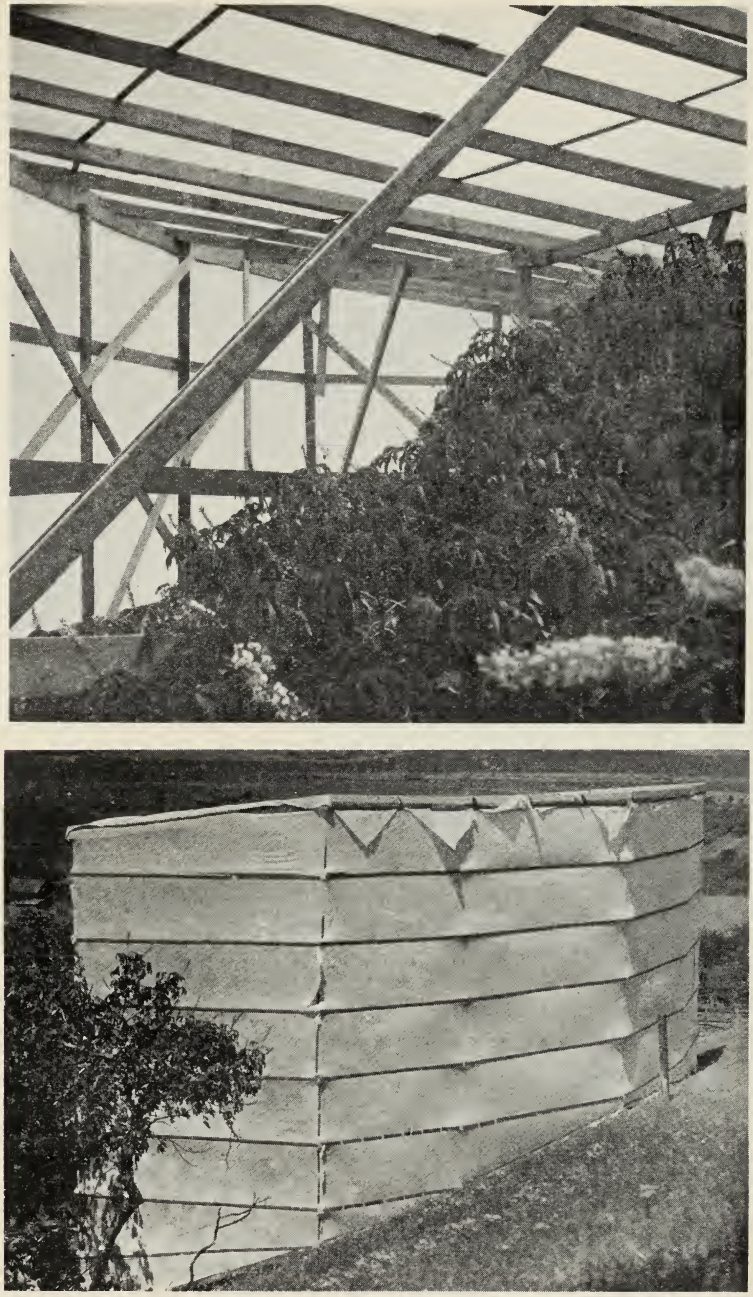
plants of an arid or semi-arid range, the distribution of this species is very spotted. This fact is admirably discussed by Coville in his "Botany of the Death Valley Expedition."

George B. Sudworth in his "Forest Trees of the Pacific Slope" records the occurrence and range of the California buckeye as follows: "Foothill and lower mountain slopes; frequent on borders of streams and cañon sides in dry gravelly soils. Forms spreading clumps interspersed with scrub oak, redbud, occasional live oak, blue oak, gray pine, manzanita, and other chaparral brush; largest in sheltered coves and gulches."

Fig. 2.—A pile of dead "buckeyed" bees four inches deep before the entrance of a hive in the Vacaville district.

The blossoming dates of *Aesculus californica* in different localities vary from April in the Winters Hills of Solano County to September in the Santa Cruz mountains. In warm dry areas the length of the blossoming period is about five weeks, while in cooler areas with moist air conditions, the blossoms keep coming on for nearly three months. Wherever the period is short, a great many of the blossom buds abort. Nectar is produced very freely in this species throughout the blossoming period, and the flow is not affected by annual conditions to nearly the extent observed in shallow-rooted plants.

Fig. 3.—The bug, *Urbisea solani* Heid., which punctures buckeye plants. Bees take up the exuding sap from these feeding punctures and carry it to the hive.



Tent over buckeye trees in which bees were confined.
Fig. 4 (above), inside of tent. Fig. 5 (below), outside of tent.

The California buckeye is a plant fairly well known, but a few words of description to help those who are not familiar with it may be given. Those who know any of the other species of Aesculus such as the imported horse chestnut present in the eastern United States will immediately recognize *Aesculus californica*. It grows to be a tree of considerable size (40 feet high) in the southern part of its range, though in the north it rarely attains a height of 15 feet and is often bushy in growth. The bark is soft and almost white. The leaves are large (3 to 5 inches long) with five palmate stalked leaflets of a rich green color. These drop from the tree early in the season and over much of its distribution area it is almost naked by mid-July. The blossoms are very showy, occurring in a thyrse 8 to 12 inches in length; the individual flowers are white or pink in color. When in full bloom, the California buckeye is by some considered one of the most beautiful of our American trees. The seed, which is ripened in a round, pulpy-green pod, is a large, soft-shelled "buckeye" from one to three inches in diameter, turning yellow and then brown at maturity.

As yet no poisonous substance has been isolated from either buckeye nectar or buckeye honey, though undoubtedly there is a poisonous material present. It seems probable that the material is a very unstable glucosid. The use of buckeye extract by the California Indians for stupifying fish in rivers and lakes was once a well-known practice. They also used the seeds for food but only after making them edible by roasting to remove the poison. The poisonous effects of the green leaves, twigs, and raw nuts upon children and livestock have been recorded in many states. During the recent war Professor M. E. Jaffa worked out a satisfactory laboratory method of removing the "bitter principle" from the nuts so that they could be used for grinding into food and feed meal, but it never became necessary to use this material for food.

The effects on bees of buckeye honey, pollen, nectar, and sap are sometimes very severe. Not only the field bees, but the adult queen and drones are affected as well as the larvae and emerging young adults. In severe cases the whole colony dies with the hive full of honey. The majority of the larvae being fed are killed outright and are in the main devoured by the adults. Those young which are not killed will pupate and emerge, if they are not so badly deformed that they are unable to do so. Adults with but four normal legs are very common. The wings of practically all emerging young never expand. Many of the adult bees become weak and die in the hives. They are

Figs. 6 and 7.—Buckeye trees in full blossom. It was in such areas as this that some of the investigations reported upon in this paper were conducted.

carried out by the survivors and dumped in front of the entrance in a great pile (fig. 2). Many of the surviving bees are deformed and seem to lack normal instincts, for they will crawl out of the hive and away from it, going toward the sun and to the tops of weeds and grass to remain until they die. The field bees seem at times to be affected least, possibly because they are more resistant than the larvae. However, nearly all of them later become unable to void fecal material and they assume the "shaky" attitude of paralytic bees. It is a common experience to find an abnormally large number of dead bees upon buckeye blossoms in the field, especially near the end of the flow. This may account in part for the small number of affected field bees sometimes noted at the hive. The queen's egg laying power is cut down to almost nothing, a condition which leads to attempted supersedure. The resulting young queen is often unable to fly or in case she is able to take the mating flight, she lays only a very small number of eggs. Arthur Dickenson, a beekeeper and queen breeder of St. Helena, states that queens reared during buckeye blossoms or immediately after are *never* any good as layers, the great majority of them being drone layers, a fact which suggests lack of fertilization. Such drones as are able to fly at all are apparently weak in flying powers. They do not appear normal in any respect. In fact, with severe poisoning, the demoralization of all the individuals in the colony is often complete.

Alfred Hengst and Charles Steves have suffered heavy losses of bees repeatedly in the Three Rivers section of Tulare County. They have at times lost over half their colonies. In some years apparently they have to choose between bees and no honey or honey and no bees, according to whether the bees are left in the valley or moved into the hills after fruit blossoming.

The many cases in which the effects of buckeye do not become very apparent can be explained in a number of ways. Other things being equal, the malady becomes increasingly severe with the greater amount and the concentration of the buckeye products brought in from the field. When other plants are yielding nectar simultaneously, the bees gather their nectars and pollen and thus dilute the buckeye poison and decrease its effects. It has been found that heavy feeding of sugar syrup throughout the buckeye flow, even where nectar from other plants is scarce, brings about a reduction of "buckeye poisoning." Where the rainfall is sufficient or the atmosphere cool and moist enough for abundant annual growth of mustard, filaree, bur clover, sages, etc., the beekeeper is not bothered with this trouble to

Fig. 8.—Buckeye trees in blossom. Looking out into the Vaca Valley.

Fig. 9.—The major portion of the trees on the low hills in the background are buckeyes. This shows how abundant they are where conditions are favorable.

any extent. Alameda and other coastal counties with the ocean fog influencing annual vegetation and with their comparatively small amount of buckeye are not so subject to this poisoning as are the counties further away from the ocean with dryer and warmer air and soil. Even in an area particularly subject to the effects the bees do

10 *a*

10 *b*

11 *a*

11 *b*

Fig. 10, *a* and *b*.—Normal adult worker bees. The body of such a bee is very hairy.

Fig. 11, *a* and *b*.—Affected field bees in the hive, no longer able to fly. They become nervous (shaky) and distended with a foul material similar to a dysenteric condition. Such bees are picked bare of hair by the teasing of normal ones evidently trying to cause their departure from the hive.

not suffer nearly so much during a wet year with abundant late spring rains as under the reverse condition. A correspondence between the amount of buckeye products and the degree to which the bees suffer is evident.

It may be that the buckeye nectar, and pollen are not alone responsible. In many cases, perhaps in all, the bees actually gather buckeye sap together with the nectar and pollen. Mr. George J. Triphon (Solano County), the most extensive migratory beekeeper of central California, first called the attention of the writer to the occurrence of a small plant bug *Urbisea solani* Heid. upon the buckeye twigs, leaves, and blossoms (fig. 3). These insects, which are normally grass feeders, migrate to the buckeye trees as the grass dries. They puncture the leaves, blossom buds, and tender twigs, and from every

12 *a* 12 *b*

12 *c* 12 *d*

Fig. 12, *a*, *b*, *c*, and *d*.—Emerging "buckeyed" bees. Many such bees are so badly deformed that legs and wings are useless to them; such individuals are pulled from the cells and thrown out of the hive. Others have normal legs but wings that never expand to be of use in flight. Notice in Figure 12 *c* the clinging shreds of material.

puncture a droplet of sap exudes. This sap is collected by the hive bees and may be the cause of the poisoning. Attempts will be made in the future to collect enough of the puncture exudate in pipettes for experimental bee feeding. Knowledge of the exact distribution of this insect, coupled with knowledge of the constancy of this habit of migration to the buckeye trees, may throw still further light upon the variation in buckeye poisoning of bees with differing localities, exposures, rainfall, temperatures, etc.

The accompanying photographs show something of how the work was carried on and also the results of the poison on the bees. The large tent frame (figs. 4 and 5) was built over a clump of buckeye trees in which bees were confined. The abundance of buckeye in certain areas is indicated in figs. 6, 7, 8, and 9. Some abnormalities occurring in adult field bees and emerging young appear in figs. 11 and 12. Figure 10, *a* and *b*, show normal bees for comparison.

Recommendations

Where conditions are favorable to the development of the malady bees should be moved to pasturage where buckeye is scarce or lacking or when practicable the buckeye trees may be cut out. Heavy feeding with thin sugar syrup will decrease the effects very markedly, but since the blossom period is so long, moving will ordinarily be more economical. The beekeeper who rents bees for fruit pollination in buckeye districts should be sure that his bees are moved away from the district before the buckeye blossoming has progressed very far. This is feasible because the time betweeen the close of fruit blossom and the start of buckeye allows ample opportunity for removal. In places where the amount of buckeye is small and other conditions are unfavorable for the development of buckeye poisoning, beekeepers need not worry about their bees save in occasional abnormally dry years.

Summary

The California buckeye has long been accused of poisoning bees. Sufficient data have been compiled by experimentation to show that this buckeye is detrimental to bees in various ways. The intensity of the effect depends upon drought, heat, abundance of the species, etc. An exudation from the feeding punctures of *Urbisea solani* (normally a grass feeding bug) is also collected from buckeye by the hive bee and may contribute to the "buckeye poisoning." Bees should be moved away during buckeye blossoming where trouble has occurred or is anticipated in accordance with conditions.

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